

AOS 760: Tropical Atlantic Variability and Meridional Modes

Read and summarize Xie and Carton, 2004 (reference below). Focus on some of the ideas in the questions below, and address these questions as appropriate.

Xie, S.-P. and J. A. Carton, 2004: Tropical Atlantic Variability: Patterns, Mechanisms, and Impacts. In *Earth Climate: The Ocean-Atmosphere Interaction*, C. Wang, S.-P. Xie, and J. A. Carton, (eds.), Geophysical Monograph, AGU, Washington D.C., 2004.

1. List some major differences between the dominant mode of variability in the Pacific (ENSO) and the dominant mode of variability in the Atlantic (the Meridional Mode). What different physical processes are responsible for destabilizing these modes in each basin?
2. How does the mean seasonal cycle affect the timing of ITCZ variations in the Atlantic? What does this imply about the seasonality of coupled ocean-atmosphere interactions?
3. Describe some major similarities and differences between the Pacific and Atlantic “Niño” modes.
4. Describe the “WES feedback”. What physical processes affect the strength of the WES feedback? How does this feedback affect the stability of meridional modes?

As an exercise, consider a Matsuno-Gill type atmospheric model thermodynamically coupled to a constant-depth slab of ocean water (a “slab ocean model”):

$$\frac{\partial}{\partial t} \begin{pmatrix} u \\ v \\ \phi \\ T \end{pmatrix} = \begin{pmatrix} -\epsilon_u & \beta y & -ik & 0 \\ -\beta y & -\epsilon_u & -\partial/\partial y & 0 \\ -c_a^2 ik & -c_a^2 \partial/\partial y & -\epsilon_\phi & -K_q \\ \alpha_{WES}/2 & 0 & 0 & -\epsilon_T + \gamma \nabla^2 \end{pmatrix} \begin{pmatrix} u \\ v \\ \phi \\ T \end{pmatrix}$$

Derive an equation for the temperature variance by multiplying the temperature equation by T , and integrating over an entire wavelength in the zonal direction, and from $-\infty$ to ∞ in the meridional direction. How does phasing between the temperature and zonal wind affect stability of the WES modes?

5. Note that there are a number of additional physical processes that may affect the structure and strength of the WES feedback. What are some of these processes, and how do they affect the strength of the WES feedback?
6. How does the North Atlantic Oscillation affect tropical Atlantic meridional mode variability? How does ENSO affect tropical Atlantic variability?

You should also consider downloading the following routines from the course website, which solve and plot the normal modes of the above model. As you plot these, think about how the phase relationships from question 4 affect the stability of the WES modes. How does the stability change with changing the strength of the WES feedback? How does the stability change with changing wavelength?